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NIGHT ROOSTING AND 'LUNAR PHOBIA' IN INDIAN FALSE VAMPIRE BAT *MEGADERMA LYRA*[1]

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(*With seven text-figures*)

Key words: *Megaderma lyra*, moon light intensity, night roosts, foraging, lunar phobia

'Night roosts' of Indian false vampire bats *Megaderma lyra* include cow-sheds, unoccupied buildings, ranging from small store rooms to large country houses. Observations of adult females occupying the night roosts suggest that the duration of occupancy of night roosts and the duration of foraging bouts vary depending on the phases of the moon and the reproductive conditions. Moon light avoidance (reflected by the duration of occupancy of night roosts) is significantly higher during breeding season than during non-breeding season in females. The behaviour of 'lunar phobia' in male *M. lyra* follows the patterns exhibited by the females. It is possible that in *M. lyra* 'lunar phobia' is probably an adaptation for reducing losses to nocturnal predators that are at least visually oriented.

INTRODUCTION

"Night roosts" of bats include places used to ingest food transported from nearby feeding areas, used by "sit and wait predators" and calling roosts as part of leks. They may also serve as centres for information transfer about the location of food patches and facilitate social interaction (See review Kunz 1982). Bats roost for short intervals in the night roosts to consume prey that they have captured in flight or on the ground. This behaviour seems most common in those bat species that take relatively larger prey. For example the intermittent returns and departures of *Antrozous pallidus* at night roost (Orr 1954, Beck and Rudd 1960, O'Shea and Vaughan 1977) commonly involve the transport of large insects. The selection and the duration of occupancy of night roosts may be influenced directly or indirectly by lunar periodicity. For instance, some desert bats apparently use more protected shelters during brighter lunar periods than during darker ones (Hirshfeld *el al.* 1977)

We have gathered data concerning the foraging behaviour of *M. lyra* from radio-tracking studies (Doris *et al.* 1991). The foraging bouts of these bats in relation to different phases of the moon. In this present study the inhibitory effects of moon light on the foraging is related to the "night roosting" behaviour in these bats.

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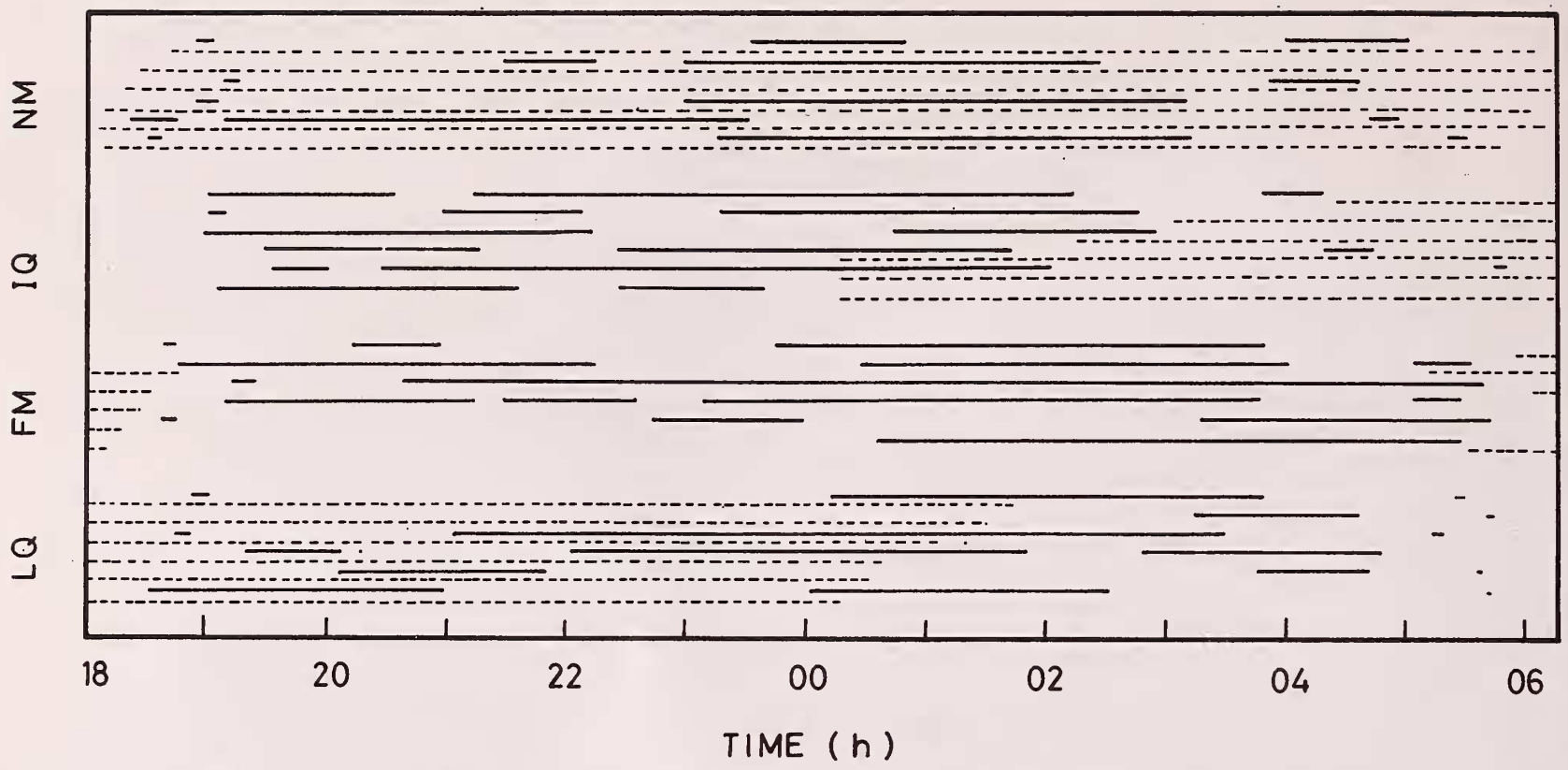

Fig. 1. Foraging activity of tagged *M. lyra* relative to the phase of the moon. Each horizontal solid line (_____) represents the time spent in the "night roost" by a single female. Dotted lines (----------) cover those hours of the night when the moon is either set or not yet risen.
The time spent in the night roosts (_____) by *M. lyra* is plotted subsequently just above (----------) "dark hours" of the night.
Abbreviations: NM — New moon; IQ — First Quarter; FM — Full moon; LQ — Last Quarter.

Materials and methods

The night roosts of *M. lyra* were mostly located 50 m to 500 m away from the diurnal temple roost (Tirunelveli, lat. 8° 44' N; long. 77°42' E, South India). They include cow-sheds, unoccupied buildings, ranging from a small store to large country houses. Bats were banded with plastic collars fitted with beads of different colours and combinations to enable individual identification of bats while night roosting (Balasingh *et al.* 1992). Weekly visits covering 36 nights representing all the lunar phases were devoted completely from dusk to dawn for observing banded *M. lyra* at night roosts. Interestingly one banded female *M. lyra* night roosting continuously in an unoccupied house was observed for 12 nights during the breeding season (February, March and April 1989) and for 12 nights during non-breeding season (September, October, and November 1989). Another banded male *M. lyra,* night roosting in a small two chambered temple was observed for 12 nights during the months of February, March and April 1989. Bats were observed from a distance of less than 5 m with a red filtered lamp or night viewing device (Litton Precision Noctovision Sniperscope). The time spent by the bat in the night roost was recorded with a stop-watch. Timings of moon rise and moon set were obtained from the tables of Ephemeris Nautical Almanac published by the Director of Observatories, Calcutta and were adjusted for longitude, latitude and Indian Standard Time (IST).

Results

M. lyra night roosted singly and not in groups. Night roosts tend to be favoured places situated 50 m to 2 Km from the day roost. During breeding seasons most of the lactating females night roosted 50 m to 500 m from the day roost. During rainy months most of the night roosts were closer to day roost while during the long summer, these night

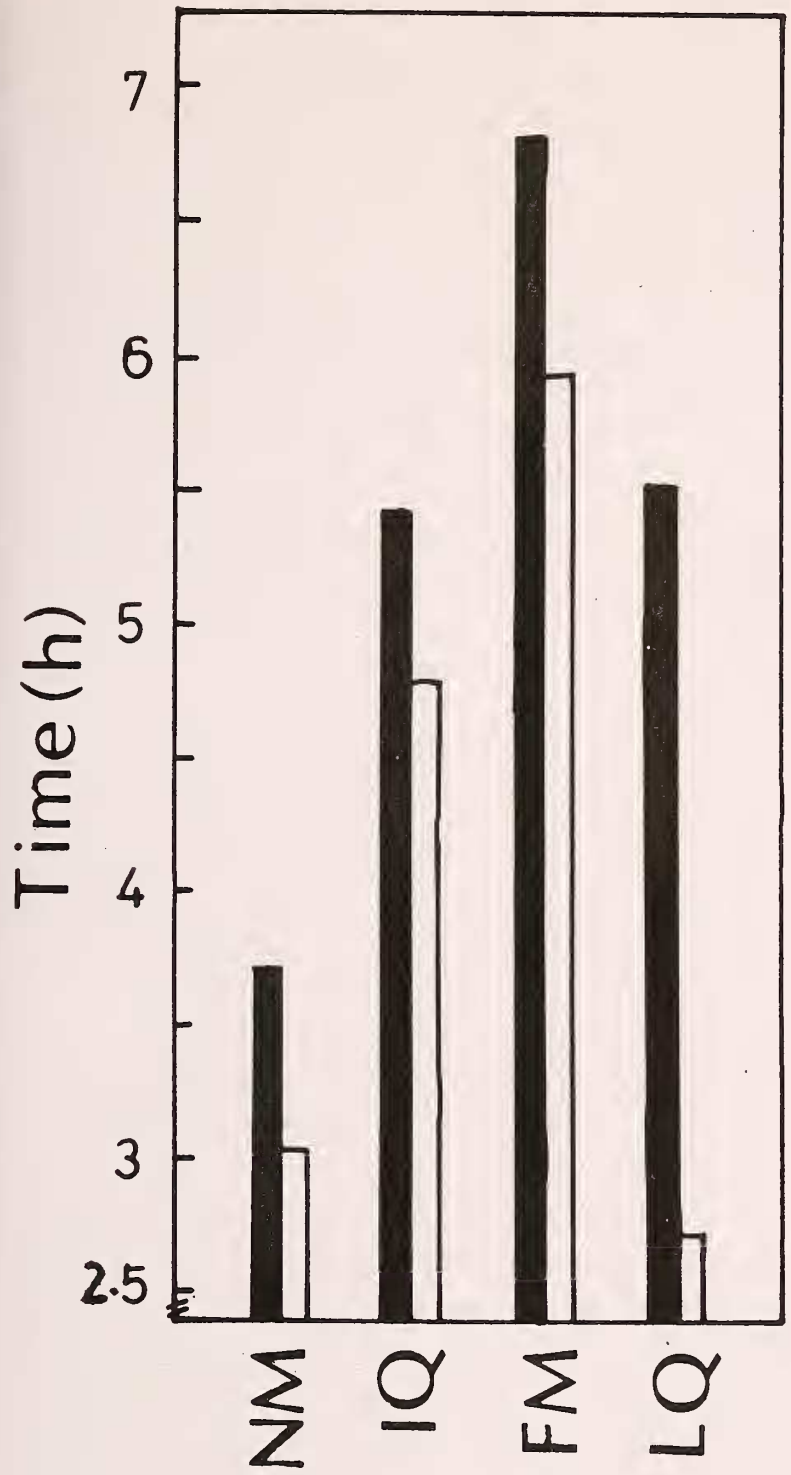

Fig. 2. Time duration of night roost occupancy by female *M. lyra* (ordinate) in relation to different phases of moon.
NM — New moon; IQ — First Quarter;
FM — Full moon; LQ — Last Quarter.
■ Breeding; □ Non-breeding.

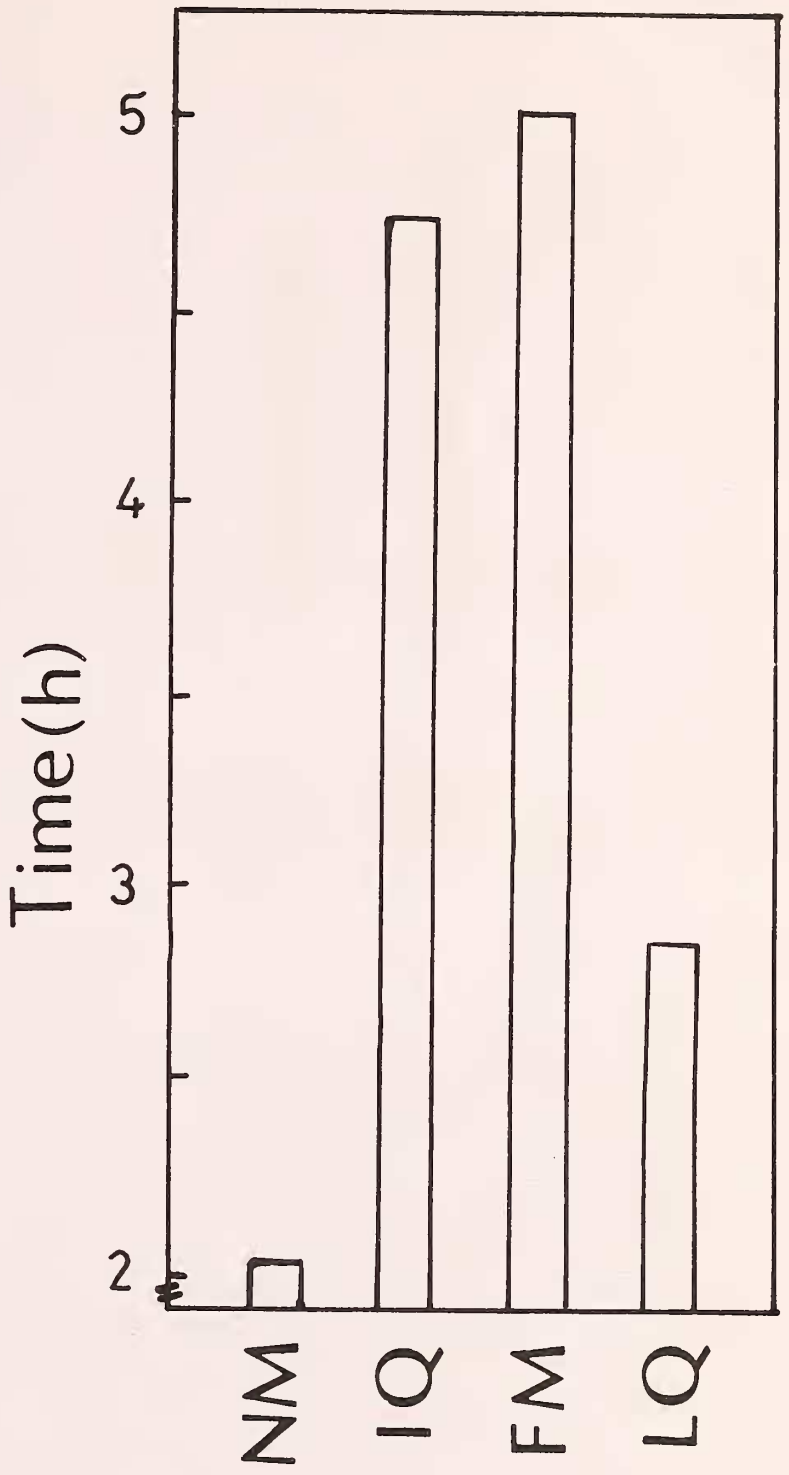

Fig. 3. Time duration of night roost occupancy by male *M. lyra* (ordinate). Other details as in Fig. 2.

roosts were temporarily vacated by the bats.

An adult female bat continuously occupied the night roost for more than 6 months. Variations in the patterns of foraging by this single female *M. lyra* were correlated with the phases of the moon. During new moon nights the bats engaged in prolonged foraging bouts and as a result the duration of occupancy in the night roosts were greatly reduced. During first half of the "bright moon" nights (first quarter moon) the bat suspended foraging activity and prolonged the stay in the night roost (Fig. 1). From the first quarter to full moon, despite the presence of a relatively bright moon at sunset, the *M. lyra* female left the day roost at the usual time but stayed away long enough to complete one or two

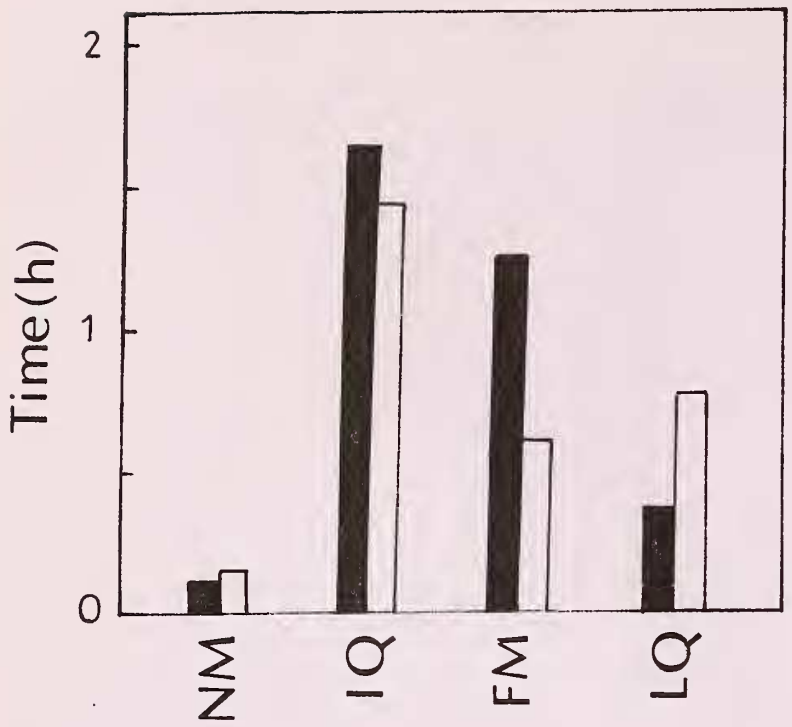

Fig. 4. Time duration of I bout night roost occupancy (ordinate) in breeding (■) and non-breeding (□) female. Other details as in Fig. 2

feeding passes before returning to the night roost.

During full moon nights, even though there was an occurrence of two or three feeding bouts they were of shorter duration. The duration of occupancy in the night roosts was significantly higher.

During most of the nights, at moon-set this female *M. lyra* re-emerged from the night roost and foraged till dawn. These data on the influence of moon phases on the foraging activity of the female *M. lyra* differs significantly during breeding and non-breeding seasons. Fig. 2 shows clearly that the time spent in the night roost by the female *M. lyra* was significantly higher during breeding season compared to the non-breeding season during all phases of the moon. During last quarter, however, the female spent significantly lesser time in the night roost during non-breeding season than in the breeding season (Fig. 2).

Figure 3 illustrates the dependency of the duration of the night roost occupancy in an individual male on the lunar periodicity. The pattern follows those exhibited by the female. During "bright moon" hours the male returned to the night roost and remained there for a long time.

Figure 4 illustrates the duration of stay (I bout) in the night roost by the female. The time spent in the night roost was relatively higher during "bright moon" hours of the first quarter moon and full moon nights. The results are also in agreement with the data collected for subsequent bouts in the night roosts (Figs. 5, 6 & 7). Even though there were variations in the time spent during different bouts in the night roost by the female during breeding and non-breeding seasons, the results of cumulative data collected for all the rest of the bouts suggest that during breeding season the moon light avoidance is significantly higher than during non-breeding season.

Discussion

Bats are "faithful" to individual night roost as long as the nearby area remains resourceful. During rainy months most of the night roosts are closer to day roosts since the ponds and the neighbouring fields are flooded with water yielding rich food resources. During long summer months bats make long commuting flights between foraging grounds and night roosts, hence several of the night roosts were temporarily shifted to distant places which are rich food resources.

The lactating females "night roosted" close to day roost during breeding season because the mother bats carried their young to the night roost and left them in the night roost while they foraged. Since they have to carry the extra baggage the mother bats preferred to night roost closer to the day roost during breeding.

The first indications of moon light avoidance behaviour were given in the observations of Tamsitt and Valdivieso (1961), Villa (1966), Wimsatt (1969), Schmidt *et al.* (1971) and Crespo *et al.* (1972) who could catch less number of foraging vampire bats and phyllostomids in their nets at moonlit nights than they could before the moon had risen or after it had set. A direct proof of the inhibitory effects of moon light was, however, obtained only after months of recording the flight activity of several captive bats such as *Artibeus jamaicensis* and *Phyllostomus discolor* under natural lighting conditions (Erkert

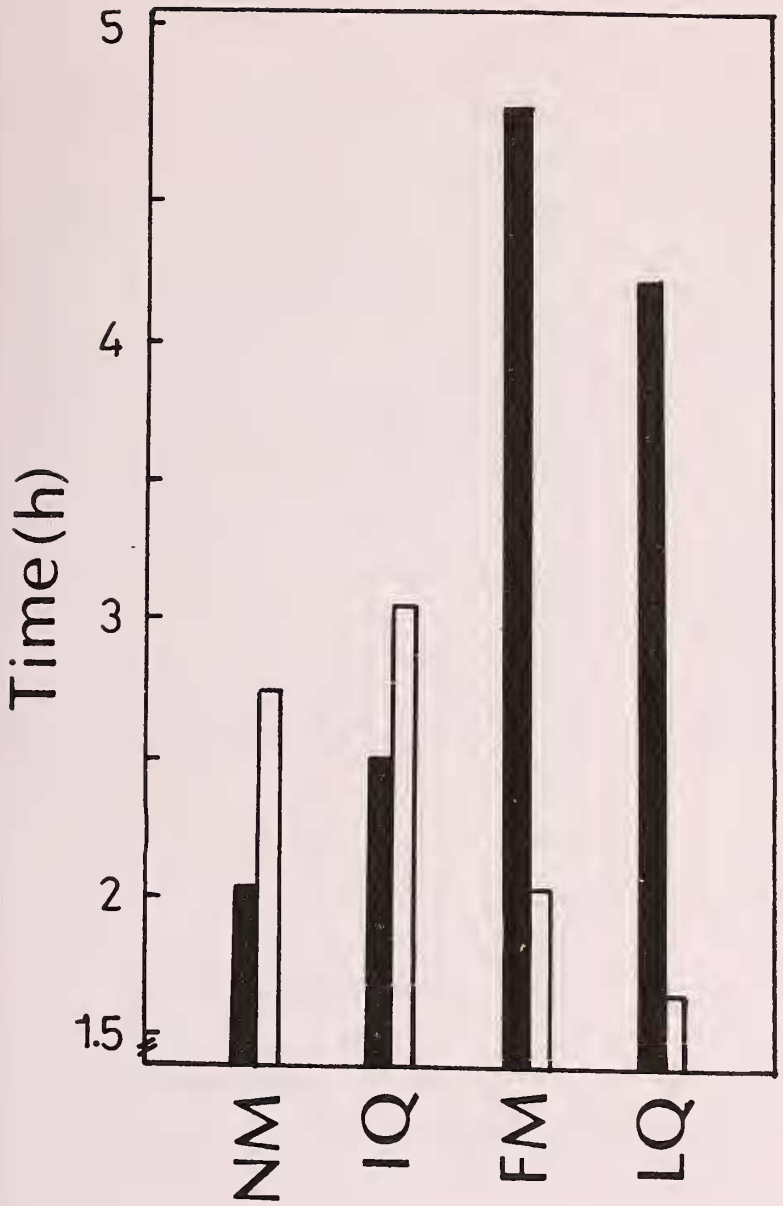

Fig. 5. Time duration of II bout night roost occupancy (ordinate) in breeding (■) and non-breeding (□) female. Other details as in Fig. 2.

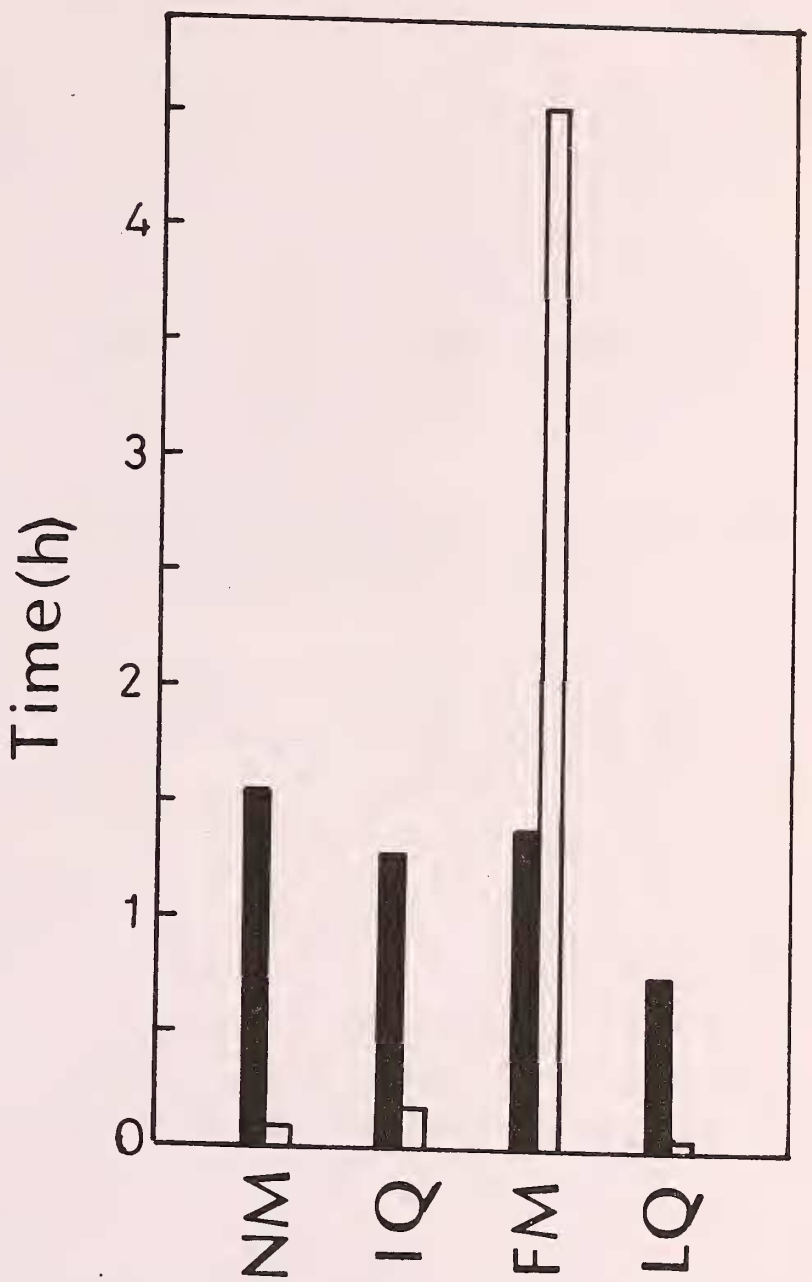

Fig. 6. Time duration of III bout night roost occupancy (ordinate) in breeding (■) and non-breeding (□) female. Other details as in Fig. 2.

1974). The findings of the studies have since been confirmed with a number of techniques, including the radio-tracking of *A. jamaicensis* (Morrison 1978a, b), bat detector recordings of the activity of various microchiropterans (Fenton *et al.* 1977) and simulation experiments on *A. lituratus* and *P. hastatus* in artificial light-darkness cycle in the laboratory (Haussler and Erkert 1978).

In addition, the differential sensitivity of bat activity patterns to moon light could also serve to reduce the direct interspecific competition among bats specialising on particular food resources by temporal separation of foraging activity based on the lunar cycle. Such a mechanism was proposed, for example, by Owings and Lockard (1971) for two rodent species of *Peromyscus* with differential responses to moon light intensities.

The moon light avoidance behaviour of *M. lyra* is not cued simply to ambient light level. *M. lyra* left the day roost after sunset even on nights when a bright moon was already present. At sunset, hunger may be an over-riding factor, causing the bats to emerge for a short bout of feeding despite the illumination from the full moon. Furthermore, the data of Lockard (1978) from field work measuring activity of kangaroo rats throughout the full range of naturally occurring conditions do clearly show that light intensity alone is not the cue, for much

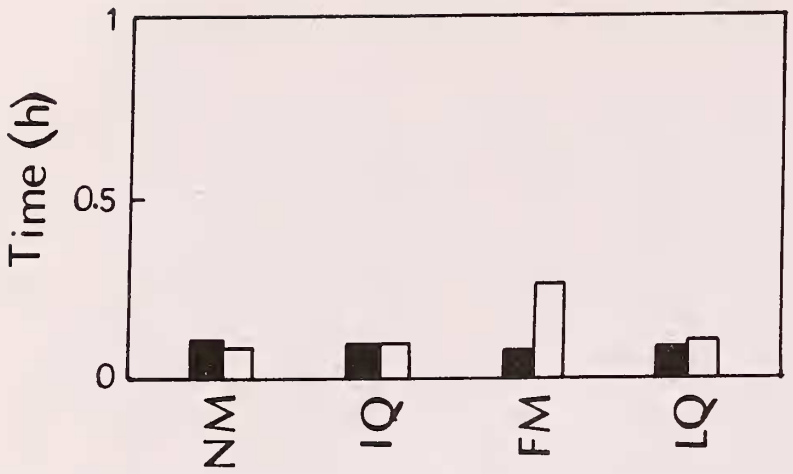

Fig. 7. Time duration of IV bout night roost occupancy (ordinate) in breeding (■) and non-breeding (□) female. Other details as in Fig. 2.

activity also occurred about the time of civil twilight (sun 6° below the horizon) when the illumination was about 10 lx. Whereas the full moon was on the order of 0.5 lx. Later, when there was much less illumination but a luminous disk was in the sky, activity was inhibited. Thus any of the three following hypotheses could account for the observed behaviour in *M. lyra*:

(1) Activity is inhibited by any reasonably conspicuous luminous disk in the sky.

(2) Activity is inhibited by a luminous disk in the sky that provided the ambient illumination which is above some threshold point.

(3) Activity is inhibited by an endogenous clock running on lunar time.

The limited data available in the present study permitted to analyse only the influence of the lunar periodicity on the night roosting behaviour in *M. lyra*. In this context, it is of interest that moon phases influence the activity of several bats directly or indirectly acting through changes in behaviour, abundance or availability of prey (Turner 1975).

We do not have complete data on the prey abundance at different moon phases over the seasons. However, it is possible that in *M. lyra* similar to other bat species "lunar-phobia" is probably an adaptation for reducing losses to nocturnal predators that are at least visually oriented (Lockard and Owings 1974, Lockard 1978, Morrison 1978a; Barclay 1985a,b; Fleming and Heithaus 1986).

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